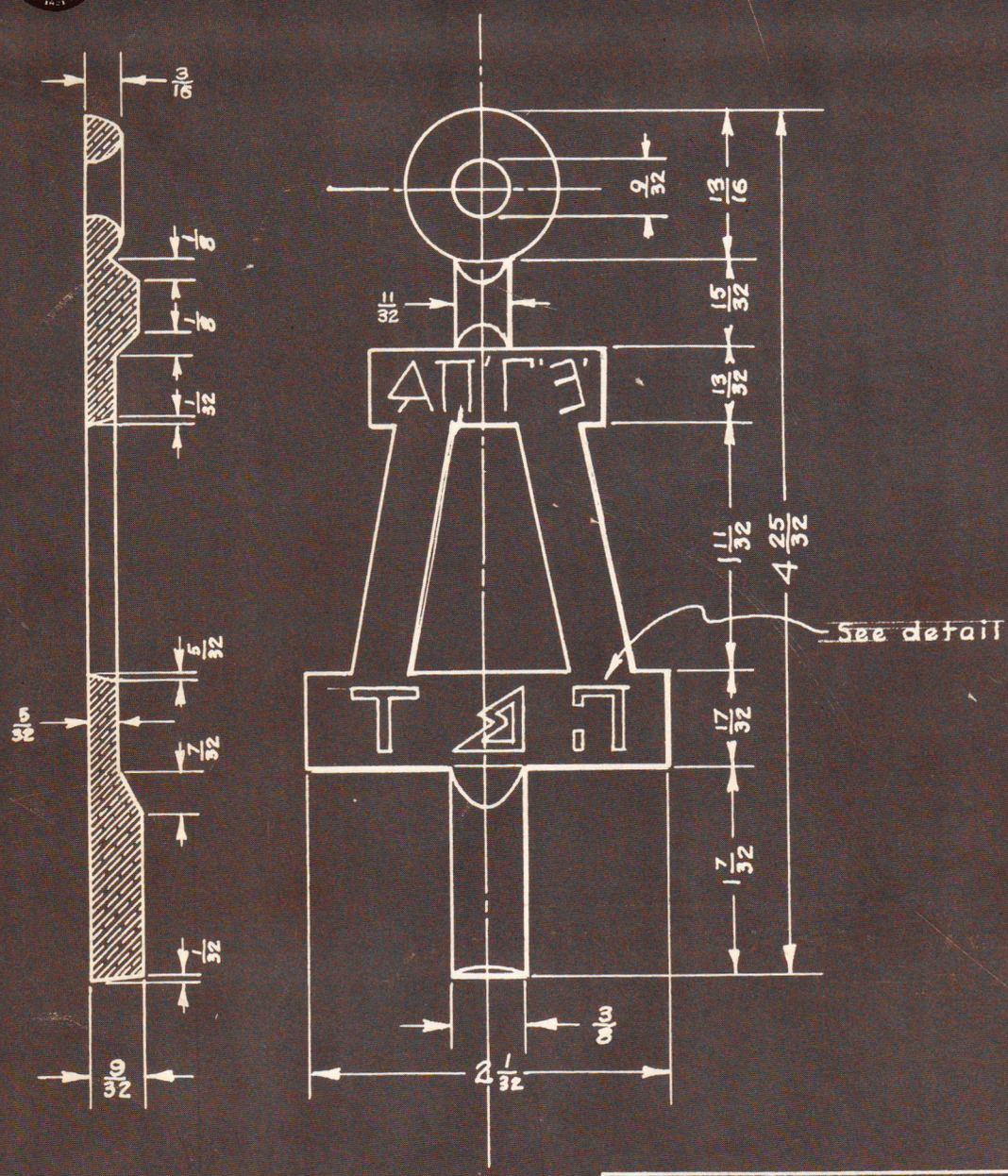
The Mechelecty

VOLUME 21 MARCH 1963 NO. 4

THE GEORGE WASHINGTON UNIVERSITY SCHOOL OF ENGINEERING AND APPLIED SCIENCE



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THE GEORGE WASHINGTON UNIVERSITY

MARCH 1963

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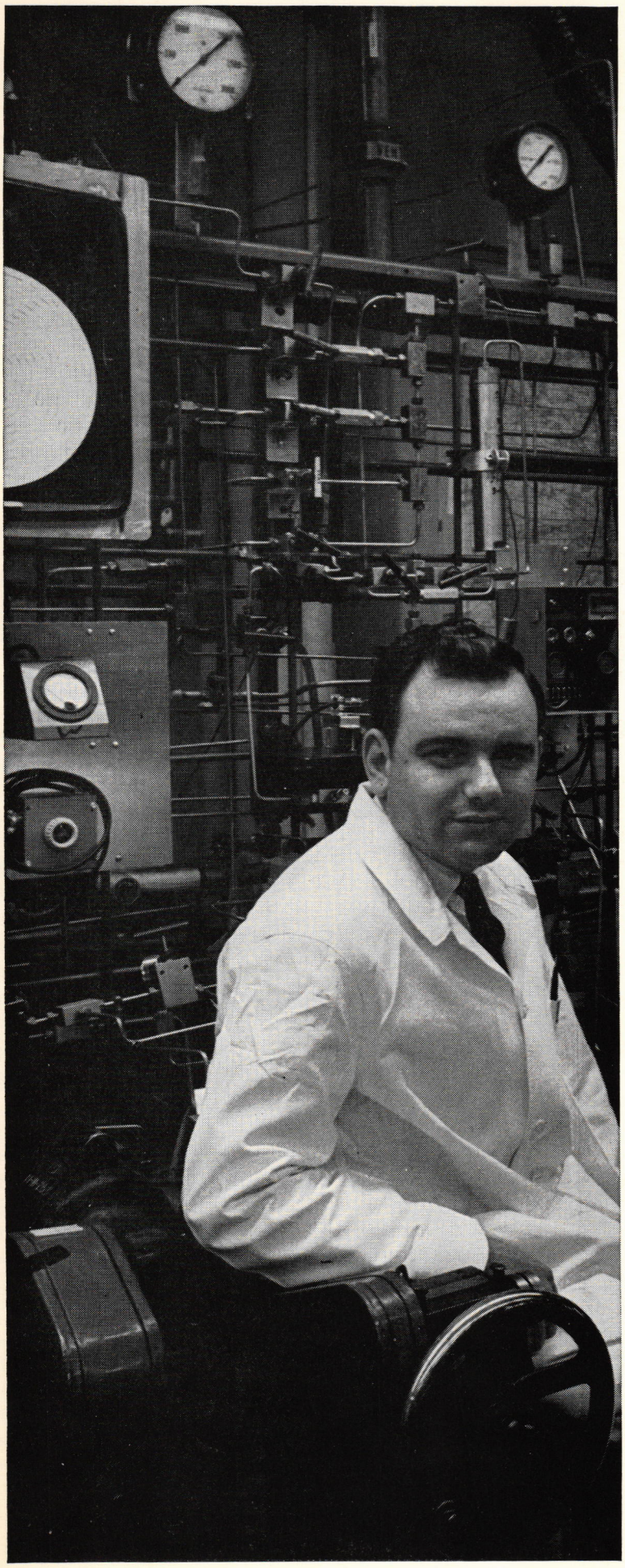

Variety: the spice of life at American Oil

by Jim Koller

"When I was first interviewed by American Oil representatives I was told I'd be given a free hand in guiding a wide variety of projects. This promise has certainly been kept!"

Jim Koller, 25 years old, came to American Oil right out of the University of Wisconsin where he earned his Bachelor of Science degree in Chemical Engineering. An Evans Scholar at Wisconsin, Jim describes his job at American Oil this way: "I work on basic chemical engineering problems, specializing in reactor design and process development problems. Before a process can go commercial, it must be tested in pilot plants. That's where I come in." Jim wants to stay in the technical research area, and plans to enroll in the Illinois Institute of Technology night school for courses in advanced mathematics.

The fact that many gifted and earnest young men like Jim Koller are finding challenging careers at American Oil could have special meaning for you. American Oil offers a wide range of new research opportunities for: Chemists—analytical, electrochemical, inorganic, physical, polymer, organic, and agricultural; Engineers—chemical, mechanical, metallurgical, and plastics; Masters in Business Administration with an engineering (preferably chemical) or science background; Mathematicians; Physicists.

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AMERICAN

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Editorial Comment

THE SOFT SELL

Now that Tompkins Hall has returned to normal after Engineers' Week activities, certain conditions should be examined. First, the engineering students, specifically the juniors and seniors, are to be congratulated heartily for their efforts in making Engineers' Week-1963 a success. Approximately 900 people visited Tompkins Hall this year representing an increase of fifty percent over last year's attendance. Visitors observed greatly increased student participation since every laboratory in the building was open for observation of student-performed experiments. Industrial exhibits this year were bigger and more interesting. The composite result indicates that any person involved in the activities should feel that his effort was fully justified. However, a better understanding of the purpose of Engineers' Week would result in increased student participation.

The purpose of Engineers' Week is twofold although each of them is of a promotional nature. The first purpose is to promote the ideals and endeavors of the engineering profession. Any person who is even casually observant of national security, industrial progress, and human benefit cannot deny that the shortage of engineers is becoming a serious problem. While freshmen enrollment in all college disciplines increased 11.5 percent last year, freshmen engineering enrollment decreased 2.3 percent. A conservative estimate indicates that a 33 percent increase in engineering graduates will be needed during the next decade. The situation becomes more ominous when the strategic importance of engineers is considered. No one would doubt the severity of our struggle with the Communist ideology which has now developed into a technological race. Consider how we would fare as a world power if our engineers had not made possible the satellites and missiles that are so closely related to our national image. Consider also the deterrent of the Polaris submarine armed with nuclear tipped missiles. Consider the less warlike technological advances such as automatic computers, automobile manufacturing plants, electric power generating capacity, commercial aircraft, communications, and untold others. It is clear that, if the disinterest in engineering education is allowed to continue, our leading position in any technological conflict will be greatly endangered.

The second purpose of Engineers' Week is to promote The George Washington University School of Engineering and Applied Science. Publicity of our school cannot really be called as important as publicity for the engineering profession but its importance is not to be denied. The reputation of a school is quite important to prospective students. However, the reputation of a school depends upon several factors, the most important being that a school must maintain an ably administered, modern educational program. In addition, publicity work must be effectively accomplished to achieve and maintain a good reputation. Many schools with excellent reputations cannot compete with the quality of education that is offered here. The new approach to education offered by the School of Engineering and Applied Science is the first in this country and many well known schools appear to be following our lead. However, a reputation cannot be obtained instantaneously and much publicity is necessary to indicate the quality of education here.

Probably the most effective method of obtaining publicity for the school is Engineers' Week activities. Many engineering schools have built their reputations directly from Engineers' Weeks and others have benefitted largely from such promotional activity. Another advantage is that Engineers' Week promotion attracts qualified students who might otherwise be drawn to other schools. High school seniors undecided about future careers may be drawn to engineering if they see that engineering students here are enthused about their education.

One excellent indication of the success of our Engineers' Week is a comparison of our enrollment with other schools. Our program, just in its beginning stages, has grown from a total of 70 visitors three years ago to 900 visitors this year. Over this same period our enrollment has increased slightly while other engineering schools in the northeastern United States have felt a drop of ten to fifteen percent. Many factors strongly indicate that successful Engineers' Week endeavors are quite effective in promoting the engineering profession and building the reputation of the participating school. The graduating seniors have done their part and now the responsibility rests on next year's students to see that Engineers' Week-1964 is an even greater success.

—D.L.J.

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NEW COURSES FOR OLD

UNDERGRADUATE

Present Course	New Course
CE 21	ApS 59-60
CE 24	ApS 59-60
CE 112	none
CE 121	ApS 59-60
CE 125	ApS 101
CE 128	ApS 62
CE 132	ApS 63
CE 135	Eng 10
CE 137	ApS 70
CE 143-144	ApS 121-122
CE 145	Eng 11-12 and Eng 13-14
CE 146	Eng 11-12 and Eng 13-14
CE 154	Eng 15
CE 157	ApS 68
CE 165	Eng 1
CE 166	none
CE 168	Eng 2
CE 195-196	Eng 199 or ApS 198
Metrology 4	ApS 107
Metrology 5-6	ApS 105-106
Metrology 111-112	Eng 49-50
Metrology 113	Eng 52
Metrology 114	Eng 53
Metrology 121	Eng 54
Metrology 131	Eng 55
EE 11-12	ApS 10-11
EE 102	Eng 19-20
EE 103	ApS 10
EE 104	ApS 11
EE 107	ApS 29-30
EE 111	Eng 49-50
EE 113	Eng 105-106
EE 118	ApS 86
EE 122	Eng 105-106
EE 123-124	Eng 101-102 or Eng 107-108
EE 127	ApS 30
EE 133	ApS 58
EE 134	Eng 19-20
EE 136	ApS 12
EE 137	ApS 32
EE 142	ApS 50
EE 171	ApS 75
EE 172	Eng 22
EE 174	Eng 23
ME 9	ApS 4
ME 10	ApS 3
ME 100	ApS 67
ME 113	ApS 85
ME 114	Eng 30
ME 118	ApS 87
ME 120	ApS 101-102
ME 123	ApS 65
ME 124	ApS 66
ME 135-136	Eng 31-32
ME 139	Eng 35
ME 143	none (ApS 110, 111, 112 may be substituted)
ME 146	ApS 64
ME 195-196	Eng 198 or ApS 198
ES 154	ApS 55
ES 154 (Lab)	Eng 103-104
ES 130	ApS 80

GRADUATE

Present Course	New Course
CE 216	Eng 201
CE 217	Eng 202
CE 218	Eng 203
CE 224	ApS 260
CE 226	ApS 261
CE 234	Eng 204
CD 235	Eng 205
CE 238	Eng 206
CE 251	ApS 250
CE 252	Eng 210
CE 253	ApS 251
CE 254	ApS 252
CE 256	ApS 262
CE 272	Eng 211
CE 275	Eng 212
CE 295-296	ApS 298 or Eng 298
EE 201	ApS 270
EE 202	ApS 271
EE 203	ApS 273
EE 211	ApS 265
EE 212	ApS 263
EE 213	Eng 233
EE 214	ApS 264
EE 215	Eng 234
EE 221	ApS 272
EE 222	ApS 275
EE 223	Eng 220
EE 224	Eng 221
EE 225	Eng 222
EE 226	Eng 223
EE 231	Eng 231
EE 232	Eng 230
EE 233	Eng 232
EE 234	ApS 286
EE 241	ApS 274
EE 242	ApS 286
EE 243	ApS 266
EE 244	Eng 235
EE 251	Eng 240
EE 252	Eng 241
EE 253	Eng 242
ME 211	ApS 280
ME 213	ApS 281
ME 215	ApS 282
ME 235	ApS 283
ME 255	ApS 284
ME 256	ApS 285
Metrology 201	Eng 270
Metrology 203-4	Eng 271-272
Metrology 214	Eng 273
Metrology 220	Eng 274
ES 201	ApS 201
ES 211	ApS 211
ES 212	ApS 212
ES 216	ApS 216
ES 217	ApS 217
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Engineering Administration	no change

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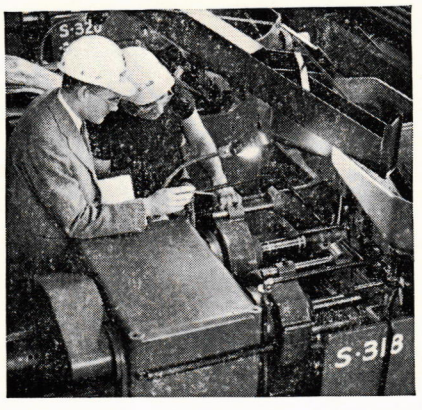

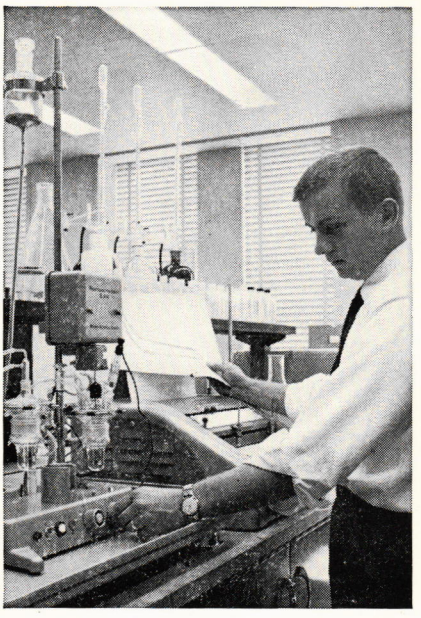

Read Our Booklet

The eligibility requirements of the Loop Course, as well as how it operates, are more fully covered in our booklet, "Careers with Bethlehem Steel and the Loop Course." Copies are available in most college placement offices, or may be obtained by writing to Manager of Personnel, Bethlehem Steel Company, Bethlehem, Pa.

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TAU BETA PI

Mr. Robert H. Nagel, Secretary-Treasurer of The Tau Beta Pi Association, speaks at the Installation Banquet.

On February 16, 1963, the District of Columbia Gamma Chapter of The Tau Beta Pi Association was installed at The George Washington University School of Engineering and Applied Science. This culminated a three-year effort by the local engineering honor society, Sigma Epsilon, to establish a Tau Beta Pi Chapter on campus. Thus The George Washington University joins The University of Maryland, Howard University, and Catholic University in a comradeship of learning in the greater Washington area.

Three years ago Professor Raymond R. Fox circulated a letter among the honor students to determine their interest in forming a Tau Beta Pi Chapter. The response was overwhelmingly favorable so the detailed process was begun. First a local honor society, patterned after a Tau Beta Pi Chapter, was formed complete with bylaws and constitution. A preliminary petition to Tau Beta Pi was drafted and Sigma Epsilon successfully underwent an official Tau Beta Pi inspection a year ago. Last fall, at the 1962 National Convention in California, the formal petition was presented and approved. All that remained to be done to become a chapter of Tau Beta Pi was the successful completion of the formal installation.

February 16, 1963 was chosen as the installation date and the work of making all of the necessary arrangements was begun. Members of Sigma Epsilon were quite active in making the arrangements but the whole process could not have been completed without the aid of Mr. Robert H. Nagel, Secretary-Treasurer of The Tau Beta Pi Association, along with Dean Martin A. Mason and the faculty of the School of Engineering and Applied Science. The following members of Sigma Epsilon were initiated into Tau Beta Pi on the afternoon of February 16.

CHARTER MEMBERS

Dr. Martin A. Mason
Kitt E. Gillilland
Thomas J. Golab
Henry C. Mayo
Richard L. Potterton
Herbert S. Wilkinson
David Lokerson
Howard T. Hill
Arthur Macurdy
David K. Trask
Donald L. Eddins
Harvey J. Flatt
Erling R. Jacobsen
Francis M. Klisch

STUDENT MEMBERS

John R. Calarco
Arthur N. Crenshaw, Jr.
George E. DeVillbiss
Douglas L. Jones
Lee Kaminetzky
Edward F. Magee
Donald A. Miller
Mendel L. Peterson, Jr.
Paul E. Treynor
Carlos A. Alonso
Ashok S. Kalelkar

Mr. Erling Jacobsen, President of D. C. Gamma Chapter.

ON CAMPUS

The Tau Beta Pi Association, national engineering honor society, was founded at Lehigh University in 1885 by Edward Higginson Williams, Jr., "to mark in a fitting manner those who have conferred honor upon their Alma Mater by distinguishing scholarship and exemplary character as undergraduates in engineering, or by their attainments as alumni in the field of engineering, and to foster a spirit of liberal culture in the engineering colleges of America.

–Preamble to the Constitution.

ALUMNUS MEMBERS

Ronald A. Grossman
Harold S. Horiuchi
James W. Joyce
Norbert J. Rendler
Arnold L. Snyder
Stephen Tsakos
Paul E. Rova
Randall Kenyon

EMINENT ENGINEERS

Dr. Nelson T. Grisamore
Dr. Herbert E. Smith
Prof. Raymond R. Fox

The installation banquet was held on the evening of February 16, at the Roger Smith Hotel. Master of ceremonies was Dr. Oswald S. Colclough, Provost and Dean of Faculties, and Dr. Joseph R. Sizoo, Director of the University Chapel, gave the Invocation. Then Dean Martin A. Mason welcomed the chapter to the university community and reminded the newly initiated members of their responsibilities as academic leaders of the School of Engineering and Applied Science. Mr. Robert H. Nagel welcomed the chapter into Tau Beta Pi and spoke of the purpose of the honor society. Mr. Erling R. Jacobsen, President of D. C. Gamma Chapter, related some of the history of Sigma Epsilon and introduced the newly initiated members. The principal speaker of the evening was Dr. Robert M. Page, Director of Research of The United States Naval Research Laboratory. Dr. Page defined progress in terms of an "all-human machine" and dwelt in some of its ramifications. Finally, Dean Rulles Allen of the University of Maryland welcomed the new chapter on behalf of Tau Beta Pi and extended greetings from Maryland Beta Chapter. Dean Allen also expressed gratitude on his personal behalf as installing officer for the ceremonies.

The charter members of Tau Beta Pi.

Newly initiated members and their friends enjoy themselves at the Installation Banquet.

Founder Edward H. Williams was born at Proctorsville, Vermont, on September 30, 1849; he died at Woodstock, Vermont, on November 2, 1933. Dr. Williams was head of the mining department at Lehigh University, Bethlehem, Pennsylvania, when he conceived and organized The Tau Beta Pi Association. His work was memorialized in 1930 by the erection of a bronze tablet, which bears his likeness, on the Lehigh University campus.

The national office of the Association, which is the office of the Secretary-Treasurer and Editor and of the headquarters staff, is located at the University of Tennessee, Knoxville, Tennessee.

ESTABLISHMENT OF CHAPTERS

Charters for new undergraduate chapters are granted only by a three-fourths favorable

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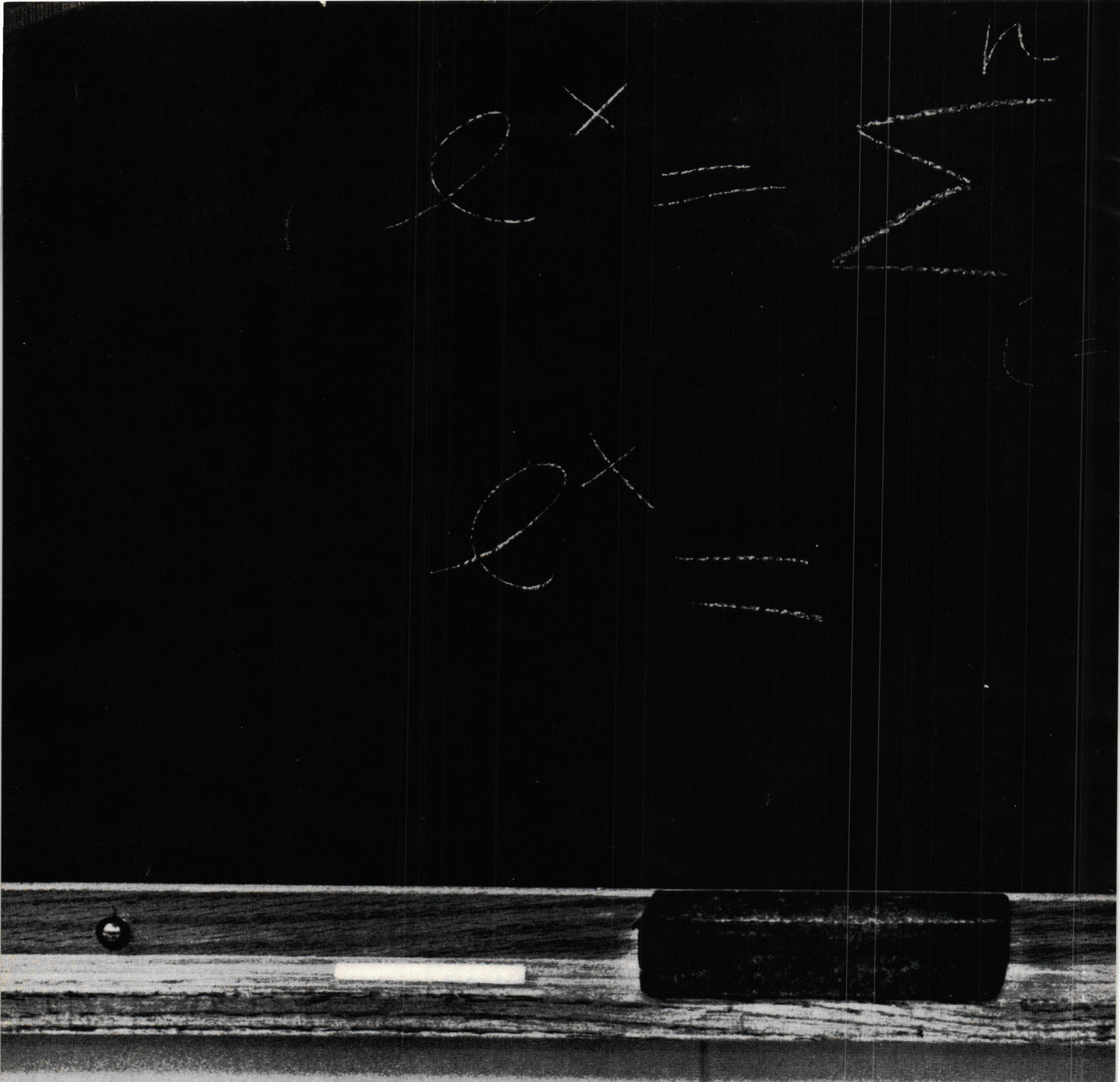

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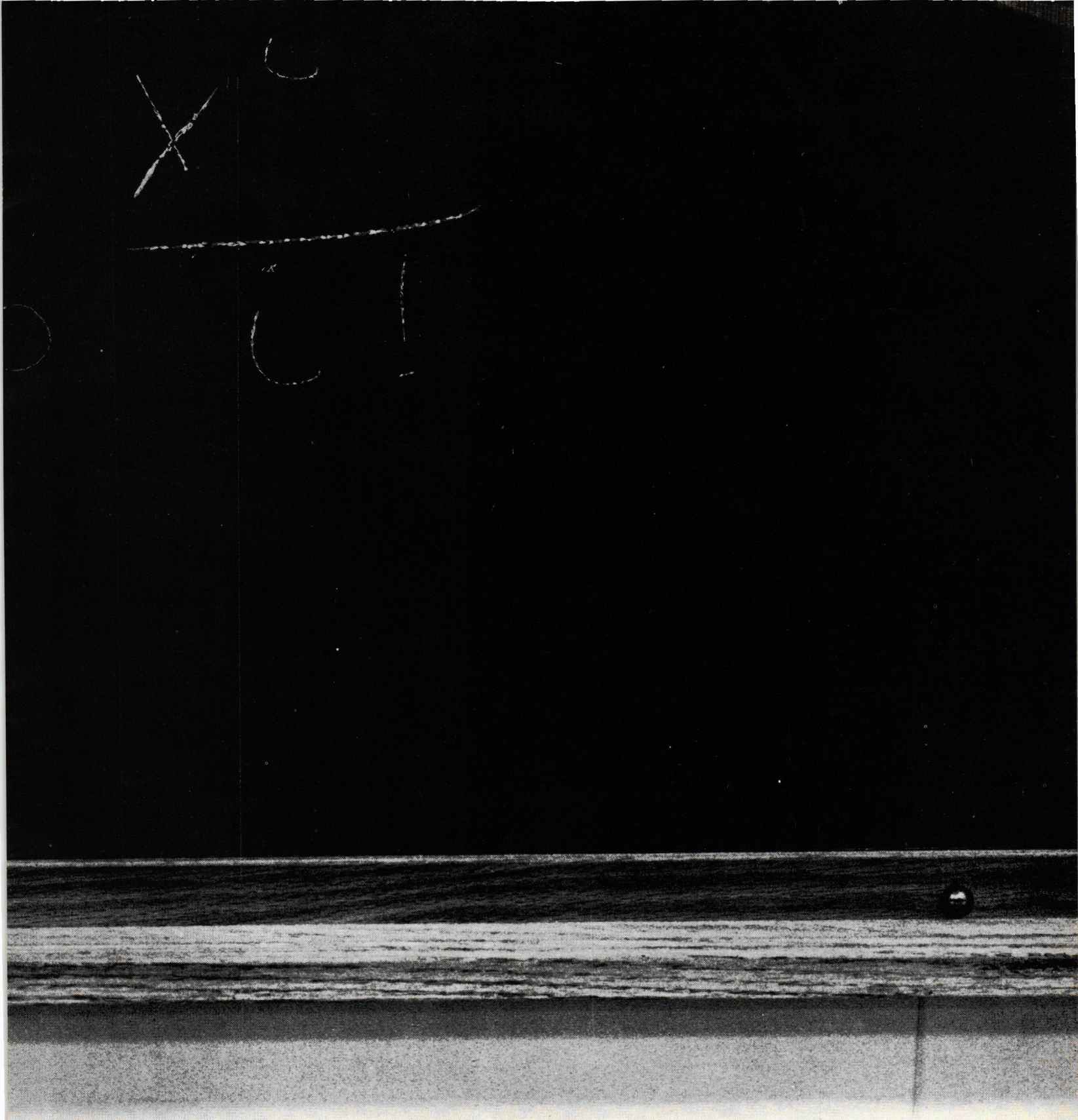

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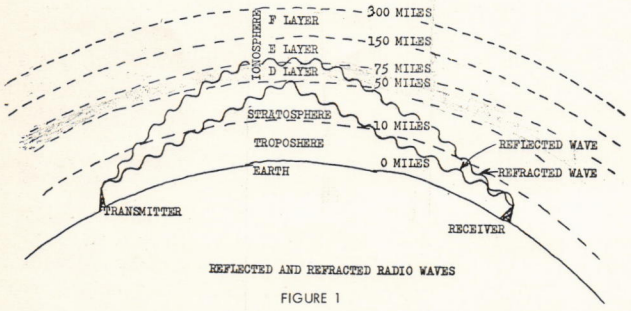
EARTH SATELLITE

INTRODUCTION

The search for more knowledge about radio-wave propagation has been important ever since radio communication became a reality. The uses of additional frequencies, different modes of transmission, and more sensitive and higher powered equipment have contributed to better reliability and expanded use of radio communication systems. For the past sixty years, engineers have adapted radio equipment to propagate radio signals through the uncontrolled, variable ionosphere. The artificial ionization of the upper atmosphere, using earth satellites, is one interesting by-product of space exploration which may help to eliminate the variations previously detrimental to radio communication.

BACKGROUND

Physicists believe that radiation from the sun ionizes the rarified gases of the ionosphere. This ionized conductive layer is similar to a large sheet of screen wire with very large mesh, allowing low frequencies to reflect while high frequencies pass through the screen more than they reflect. The earth shields much of the atmosphere from the sun's radiation, causing areas of the upper atmosphere to reach very low ionization levels, and thus lose the reflective property.



REFLECTED AND REFRACTED RADIO WAVES

FIGURE 1

At times, the sun sporadically generates over a thousand times its normal radiation. When this radiation reaches the earth, the atmosphere is ionized down to very low altitudes. This layer can shield radio antennas and prevent effective radiation by blocking all paths of radio propagation.

This unpredictable phenomenon, known as a sun spot, causes serious radio blackouts to almost all radio communications in the one-to-fifty megacycle region.

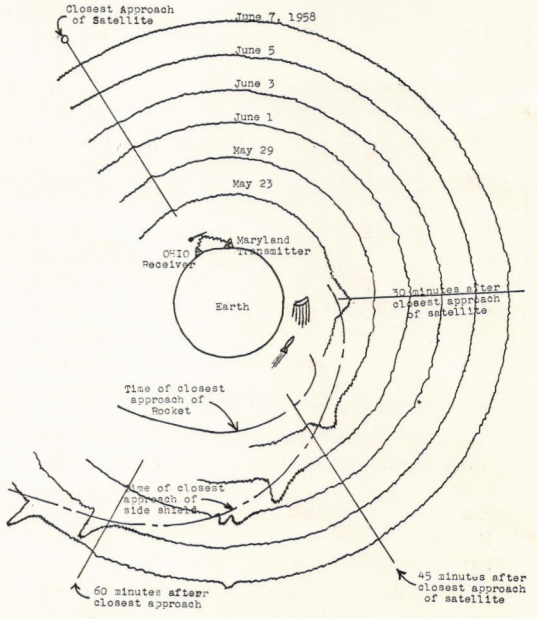
But ionization of the upper atmosphere can also be produced by meteors streaking through the sky, causing sporadic improvement in radio wave refraction in the twenty-to-fifty megacycle band. Meteor showers are difficult to study because of their short-lived, random occurrence.

However, a new type of meteor shower began back in 1957, when Sputnik I was placed in orbit. This meteor was not only predictable, but was also easy to study because of its long life. Since the number of satellites in earth orbits is growing and should continue to increase in the future, we ought to examine their effects on our atmosphere.

STUDIES BY DR. KRAUS

After Sputnik I was placed in orbit, Dr. John D. Kraus observed signal strength variations of WWV, a standard frequency station located near Washington, D. C., and 330 miles from the receiver located at Ohio State University Radio Observatory. A chart of his observations is shown in Figure 3. He noticed that substantial signal increases occurred approximately at times when the rocket was between Washington, D. C., and Ohio. Closer examination of the data revealed that small variations within each signal enhancement were remarkably regular, with a period of fifty-nine seconds. Indeed, this was the approximate tumbling rate of the rocket. Dr. Kraus theorized that the instrumented package was too small to generate sufficient ionization to reflect radio waves. However, part of the rocket body was large enough to generate a reflective ionized cloud.

The chart of Figure 2 was laid out so that the upper line is the point of closest approach of the instrumented package, as determined by radio astronomy. The time of closest approach of the rocket was determined from optical tracking data.



TIME, POSITION, SIGNAL STRENGTH PLOT of Sputnik I

FIGURE 2 (After Kraus)

Donald Custis Lokerson,
Electrical Engineering Student
The George Washington University
Graduated B.E.E., 1962

Now employed by NASA, Goddard Space Flight Center

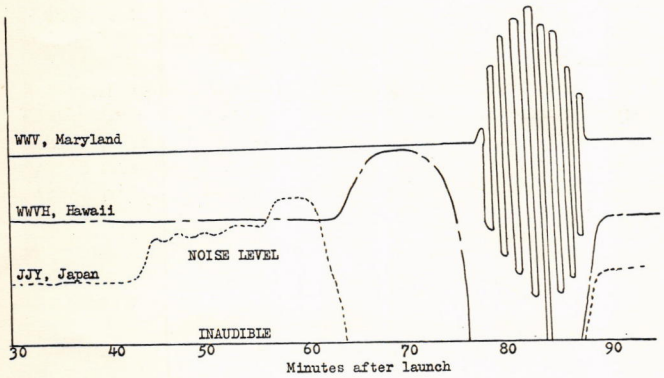
IONIZATION

by Donald Lokerson

The large signal increase between the instrumented package and the rocket was attributed to the side shield of the rocket, tumbling in space, and generating a uniformly varying ionized layer. These observations showed very clearly that such effects were indeed observable in the twenty megacycle band, and deserved further study.

EXPERIMENTS USING ECHO I

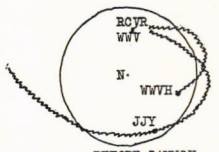
In May, 1960, The National Aeronautics and Space Administration launched a one hundred foot plastic balloon from Cape Canaveral. The author had visualized the possibility that this large spherical shape should produce a rather uniform ionization cloud of much larger proportions than previously generated by ordinary satellites. On the morning of launch, the upper atmosphere was predicted to be unstable; however, observation before launch did not reveal any unstable conditions. The changes in propagation conditions strongly suggested a disturbance related to the launching of the ECHO I satellite. The balloon did not quite reach orbital velocity, and therefore did not complete more than one orbit. The observed signal strengths are graphed in Figure 3. A simplified diagram of probable propagation paths utilized at specific times are diagramed in Figure 4.



SIGNAL STRENGTHS OF STATIONS ON 15 MEGACYCLES DURING ECHO I ORBIT
FIGURE 3

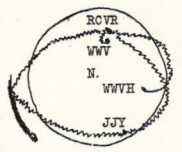
In part A of Figure 4, notice the relative positions of the receiving station, and the stations being monitored. Before launch, the dark side of the earth had a residual ionization level sufficient for JJY to be barely detectable, and for WWVH to be heard in the noise. The ionization on the sunny side of the earth was not sufficient to reflect the waves around the earth in the receiver until the ionization cloud was generated by the balloon, as shown in Figure 4-B. This would cause JJY to increase in signal strength but to be somewhat unstable because of interaction inphase between the two propagation paths. The signals transmitted by WWVH and WWV should not have been and were not affected.

Sixty-five minutes after launch, as shown in Figure 4-C, the balloon progressed to a point between JJY and WWVH. However, signals from



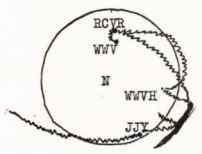
BEFORE LAUNCH
JJY - WEAK, STEADY
WWVH - WEAK, STEADY
WWV - STRONG, STEADY

FIGURE 4A



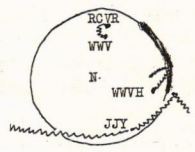
30 - 60 minutes after launch
JJY - STRONG, UNSTEADY
WWVH - WEAK, STEADY
WWV - STRONG, STEADY

FIGURE 4B



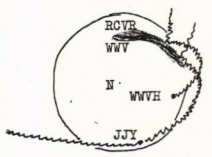
65 minutes after launch
JJY - NOT HEARD
WWVH - STRONG, STEADY
WWV - STRONG, STEADY

FIGURE 4C



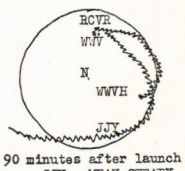
75 minutes after launch
JJY - NOT HEARD
WWVH - VERY WEAK
WWV - STRONG, STEADY

FIGURE 4D



80 minutes after launch
JJY - NOT HEARD
WWVH - NOT HEARD
WWV - UNSTABLE

FIGURE 4E



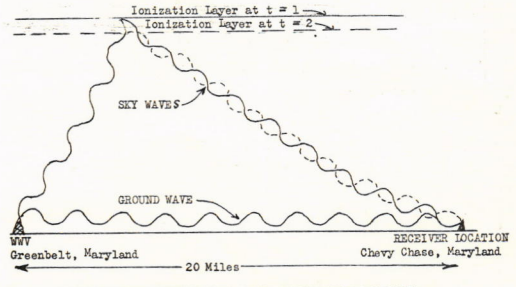
90 minutes after launch
JJY - WEAK, STEADY
WWVH - WEAK, STEADY
WWV - STRONG, STEADY

FIGURE 4F

JJY were inaudible, whereas signals from WWVH were increased in strength. The ionization cloud shielded the JJY's signals from the receiver, while, at the same time, the ionization cloud reflected the signals from WWVH toward the receiver.

Seventy-five minutes after launch, the balloon was between WWV and WWVH, as shown in Figure 4-D. The cloud now blocked not only JJY, but also WWVH, so that signals from the latter station were barely detectable.

Eighty minutes after launch, the cloud surrounded WWV and the receiver, causing the rapid fading of the signals from WWV. The sky wave first cancelled with the ground wave reception and, immediately afterward, added with the ground wave, as shown in Figure 4-E and Figure 5.



EFFECT OF IONIZATION LAYER CLOSE TO RECEIVER LOCATION
FIGURE 5

--Continued on Page 22

a message to graduating engineers and scientists

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YOUR EYES CAN BE ON THE STARS

SPECIALISTS IN POWER... POWER FOR PROPULSION—POWER FOR AUXILIARY SYSTEMS.
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The glamour and excitement of space age programs often obscure a fundamental fact. It is simply that farsightedness must be coupled with sound, practical, down-to-earth engineering if goals are to be attained. This is the philosophy upon which Pratt & Whitney Aircraft's position as a world leader in flight propulsion systems has been built.

Almost four decades of solid engineering achievement at Pratt & Whitney Aircraft can be credited to management's conviction that basic and applied research is essential to healthy progress. In addition to concentrated research and development efforts on advanced gas turbine and rocket engines, new and exciting effects are being explored in every field of aerospace, marine and industrial power application.

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If you have interests in common with us, if you look to the future but desire to take a down-to-earth approach to get there, investigate career opportunities at Pratt & Whitney Aircraft.

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For further information regarding an engineering career at Pratt & Whitney Aircraft, consult your college placement officer or write to Mr. William L. Stoner, Engineering Department, Pratt & Whitney Aircraft, East Hartford 8, Connecticut.

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TAU BETA PI ON CAMPUS—Cont. from Page 7

vote of the Convention. Recommended minimum qualifications of petitioning groups and their institutions, as set forth in Tau Beta Pi's Bylaws, are as follows:

That 120 net weeks of instruction be given for engineering bachelor's degrees.

That the institution grant 40 or more engineering bachelor's degrees a year.

That three engineering curricula be fully accredited by the Engineers' Council for Professional Development.

That the petitioning group have been organized as a local society along Tau Beta Pi lines for two years.

That at least two members of the faculty be members of Tau Beta Pi.

That a majority of the engineering faculty be members of their respective national technical societies.

Undergraduate chapters are administered by a corps of officers including a president, vice-president, recording secretary, corresponding secretary, treasurer, and cataloger, all of whom must be active members of the chapter, although not necessarily undergraduates. An Advisory Board consisting of the president, vice-president, and corresponding secretary of the chapter and four alumnus members of the Association (usually faculty) acts in a judiciary capacity at the local level. The president is usually his chapter's delegate to the Convention. Undergraduate chapters draw up their bylaws which set out, in further detail than is covered by the national Constitution and Bylaws, operating procedures followed by the local group.

MEMBERSHIP REQUIREMENTS

Candidates eligible for election to membership fall into four general categories:

1. Undergraduate students meeting the scholastic requirements.
2. Alumni of the college whose chapter may consider them, who met the scholastic requirements as undergraduates.
3. Alumni of a college other than the one whose chapter may consider them, who met the scholastic requirements as undergraduates.
4. Engineers of high attainment in the profession, regardless of college attended, undergraduate scholastic record, or educational background.

Undergraduate students must stand in the top eighth of their class in their next-to-last year or the top fifth of their class in their last college year to be eligible for consideration. A quota limitation is placed on the number of first term "junior" electees; these electees are designated Honor Students. The remainder of the top eighth of the "junior" class is eligible for election in their second semester or second or third quarter.

Many chapters set a scholastic-grade deadline below which candidates are not considered, such deadline being higher than that required as a minimum by the Constitution. The usual purpose of such chapter-imposed requirements is to reduce to a workable quantity the number of scholastically eligible candidates.

Elections and initiations by the undergraduate chapters are normally held twice a year, in the fall and winter or spring terms of their institutions.

Membership in Tau Beta Pi is limited to men, although women are eligible under the same rules for award of the Women's Badge.

In addition, Tau Beta Pi has required that each undergraduate student elected to membership write an essay, preferably on a non-technical subject, and containing from 500 to 1,500 words, for submission to his chapter. These papers, traditionally called pledge essays, have been judged by the chapter, and the winner in each competition has been awarded a prize. The prize has long been paid for, under one plan or another, by the national organization. After several earlier trials, a national competition for the chapter-winning papers in each fall and spring election class was instituted by the 1950 Convention, with the judging done by a committee of alumni recommended by the Alumni Representative and with cash prizes, ranging up to $100 plus a certificate, for the best essays.

FELLOWSHIPS

The Fellowship Program is the major tangible objective of Tau Beta Pi. It is a time-proven idea which has opened a splendid new field of opportunity for the honor society. The plan was adopted by the 1928 Convention as a result of the recommendation and labors of President A. D. Moore. From the first the purpose has been to finance, for a select group of members chosen for merit and need, a year of graduate study at any college in any field of engineering, requiring only that the applicant shall have a definite purpose and that at the year's end he shall submit a statement summarizing his work.

During the operation of the Program a year of graduate study in engineering has been made possible for 164 members, by outright gifts from the Association, from alumni contributions, and from industrial donations to an amount of over $160,000.

The resources of Tau Beta Pi's Student Loan Fund are available at any time to student members who otherwise would be without sufficient money to remain in college until the end of the current year or to complete their courses. Loans of any amount from $25 to $500 are made for a maximum of three years, and the rate of interest is three per cent per annum on the unpaid balance. An application for a loan to an undergraduate student must be approved by the president, recording secretary, and treasurer of the member's chapter and by the head of the department in which he is studying. An application for a graduate loan must be approved by the student's department head. Notes for more than $50 must be cosigned by a financially independent person usually the student's parent or guardian.

INSIGNIA

The official badge of The Tau Beta Pi Association is the yellow gold Bent engraved on the reverse side with the member's name, class, and chapter. The badge is of the charm type, being originally designed in 1885 to serve as a watch key, and is given to every initiate. It is also available in white gold and with a pin fastener. Members may also wear the official recognition button or ring. Women's Badges may be worn only by those to whom they have been awarded.

THE BELL TELEPHONE COMPANIES SALUTE: PAUL SAEGER, JR.

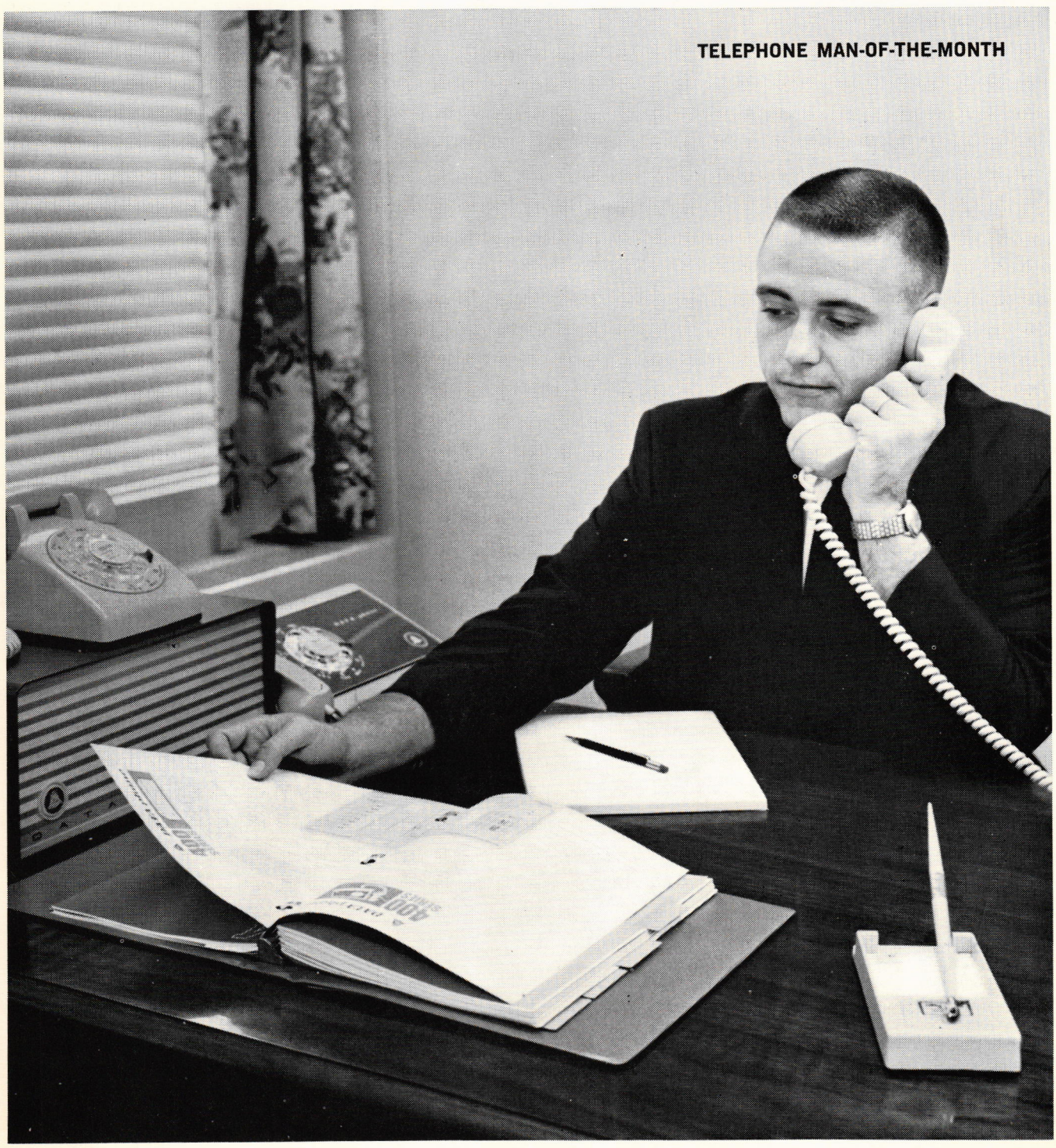
Paul Saeger (B.S.E.E., 1957) just received another promotion in Southern Bell's Nashville District. He was named Account Manager in the Marketing Department. He'll mainly be concerned with Data Processing.

On earlier assignments, Paul engineered outside plant additions for the Nashville District and set up the fundamental plans for the city's Educational TV program.

In 1961, he joined the Transmission Engineering group in the Tennessee Area Office and designed carrier systems, switchboards and special service circuitry.

Paul Saeger and other young engineers like him in Bell Telephone Companies throughout the country help bring the finest communications service in the world to the homes and businesses of a growing America.

BELL TELEPHONE COMPANIES



MECH MISS

Judy Allen

IEEE

Activities are the byword of Judy Allen, this month's Mech Miss. She is Chairman of Colonial Boosters, President of the Student National Education Association and Intersorority Athletic Board. She is also Treasurer of Chi Omega and Delphi and she was a member of Student Council. As a result of these and other accomplishments, Judy was recently elected to Who's Who in American Universities and Colleges. Judy is an elementary education major and she is now student teaching the second grade.

HOW TO SUCCEED IN SCHOOL

Engineering problems are unique in that quite often the answers are provided, at least implicitly, with the questions. The student, in an attempt to obtain the required solutions, will frequently resort to somewhat non-rigorous, if not incorrect, mathematical devices. There is sound reasoning behind such tactics, however. In general, engineering students cannot correctly solve problems posed by textbooks or by instructors: a natural immunity exists. But because these students are collectively more brilliant than their non-engineering counterparts and also, it goes without saying, the entire Engineering School faculty, various non-rigorous techniques may be employed to arrive at the desired solutions with a minimum of effort on the student's behalf and a maximum of confusion on the instructor's behalf. This is the desired end.

The engineering student, bright as he is, may still wonder why he can utilize irregular methods and not be penalized. He will reason that the members of the faculty are not as ignorant as they outwardly appear to be, and that some may even have attended college for a short period of time where they, too, were trained in the art of fallacious reasoning.

The answer to the above inquiry is quite simple. First, instructors, by nature, do not retain anything they have learned for any measurable length of time, hence any techniques they may have been introduced to in their past are long forgotten. Second, success in the use of non-rigorous mathematics is heavily dependent upon external factors--how busy the instructor is, how long the particular assignment is, how well camouflaged the techniques are, how disarranged the student's paper is, and the like. The inherently lazy instructor will usually check only the answer in a homework paper, reasoning that a correct answer implies a correct method of attack. Good for him! Also, if the assignment or examination is lengthy, or if the instructor has little time to grade papers, he will tend to skim over minor points. Good for him! If the student's paper has enough wrinkles, erasures, arrows, cross-references, etc., the instructor will not try to understand everything on the paper because of the sheer complexity of the organization of the paper. Good for him!

Every student develops his own methods of conveying to instructors the apparent wealth of knowledge possessed in each course. Below, some of the more well known devices are presented for contemplation. The student should realize that principles are being illustrated, even though the mathematics is glaringly incorrect. It is the responsibility of the student to employ the techniques discreetly and in a manner which will bring credit and honor to himself and his fellows.

The first method is of relatively modern origin, but it is more of a desperation maneuver than anything else. The object is to take the derivative of a constant and to arrive at an answer different from zero. In the fierce fury of examinations or in huge homework assignments, this small error may easily be overlooked if done in a very non-chalant manner. Here is a simple example:

PROBLEM: Prove that, if s=displacement, t=time, and $s = 3t^2 + 4t + 3$, then, velocity at $t = 0$ is 4.

SOLUTION: Velocity is ds/dt. The plan of attack is obvious. One need only differentiate s with respect to t and evaluate the result at $t = 0$. But suppose now the student performs the differentiation with an error and finds that

$$ds/dt = 6t + 4t$$

and at $t = 0$: $ds/dt = 0$ and not 4. Should the student worry? Of course not! He should erase the above computation and mentally proceed as follows:

$$ds/dt = 6t + 4t + d3/dt$$

A quick check shows that $d3/dt = 4$ at $t = 0$ is a sufficient condition to obtain the correct answer. So the student calculates

$$d3/dt \doteq \Delta\, 3/\Delta\, t \doteq 4$$

For one place accuracy on a slide rule, the number 3 is really 3 ± 0.5, so $\Delta\, 3 = +0.5 - (-0.5) = 1.0$. Hence

$$d3/dt \doteq 1.0/\Delta t = 4$$

and so $\Delta t = 1/4$ in the neighborhood of $t = 0$.

All of the above was done mentally or on scratch paper; on the homework assignment or the examination paper, the student places the statement: "In the neighborhood of $t = 0$, the

WITHOUT REALLY TRYING

by Lee Kaminetzky

change in t is 1/4." The instructor will not know where this came from or even what it means, but this is the whole beauty of the art. The student proceeds:

$$ds/dt = 6t + 4t + d3/dt \doteq 10t + \Delta\ 3/\Delta t$$

$$= 10\ t + 1.0/0.25 = 10\ t + 4$$

The velocity at t = 0 is therefore

$$ds/dt = 10(0) + 4 = 4$$

QUOD ERAT DEMONSTRANDUM

The preceding illustration is quite elementary, and most instructors would notice the error and reward the student commeasurably. But as was mentioned above, the object of the example is to illustrate a principle. Suppose the differentiation was performed as part of a problem in circuit analysis, where differential equations are scattered liberally across one's paper. A small aberration in differentiation would surely go unnoticed. Thus this method can be used in principle, if due care is taken to avert emphasis from the calculation in question.

Another important area in which slight errors can benefit students is the field of vector analysis. Quite often if the student is careful to obscure his work, the dot product and cross product can be interchanged at will to provide many fascinating results. It is not often that an instructor will use his precious time to figure out that $\overline{i} \cdot \overline{i}$ is not zero or that $\overline{j} \times \overline{j}$ is not one. The manipulation of unit vectors, as shown, can eliminate unwanted terms whenever such is deemed necessary.

The appearance of a sign opposite to that desired can often be remedied by either of two ways through vector analysis. The earlier of the two is the interchange of terms in a cross product, since $\overline{a} \times \overline{b} = -(\overline{b} \times \overline{a})$. This is done with facility, and many an instructor will not deny the veracity of such formulas as $\overline{M} = \overline{F} \times \overline{r}$ and $\overline{v} = \overline{r} \times \overline{\omega}$, where $\overline{M}$ = moment, $\overline{F}$ = force, $\overline{r}$ = radius vector, $\overline{v}$ = velocity, and $\overline{\omega}$ = angular velocity.

The other means of changing signs is gotten from the use of a pictorial representation of a cartesian coordinate system. Many students are enthralled by the possibilities of using LEFT handed coordinate systems and taking cross products like $\overline{i} \times \overline{j} = \overline{k}$. Not only is this method fun to use, but it has been known to deceive many engineering instructors.

One other point to be made about vector analysis is that the derivative of a unit vector in rectangular coordinates is zero, whereas in cylindrical and spherical coordinates, it is not. If the student must eliminate some terms of an expression, he may successfully escape the scrutiny of the instructor by differentiating non-cartesian unit vectors, obtaining a zero result, and obscuring the calculation.

A favorite means of avoiding responsibility and of diguising lack of knowledge by both students and instructors is the use of some trite phrases like the following: "it is obvious that. . ."; "it is evident that. . ."; "it is self explanatory. . ."; "it is readily seen that. . ."; "it follows. . ."; and "time does not permit derivation, but. . .". These phrases should appear on papers whenever a student does not know what to do, but he vaguely remembers some equations that he has seen. The professor is given the impression that his student has a good knowledge of the course material (for how else would equations be intuitively obvious ?), and everyone is satisfied with the results.

The following "identities" have been used successfully in many varied circumstances:

(1) $(-x)^{1/2} = -(x)^{1/2}$

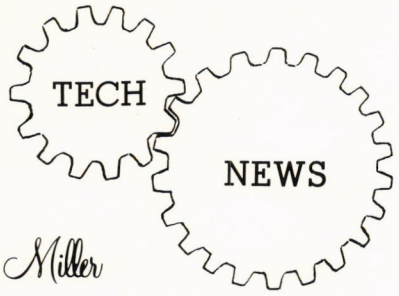
(2) $(a^2 \pm b^2)^{1/2} = a \pm b$

(3) $\log cx = c \log x$

(4) special case: $\log (-x) = -(\log x)$

(5) $\sin 60^\circ = 1/2 \cos 30^\circ$
$\cos 60^\circ = 0.866 = \sin 30^\circ$
$\sin 45^\circ = 1.414 = \cos 45^\circ$

If one is careful in employing the above principles, he will easily succeed in school without really trying.



by Don Miller

SCHOFIELD PROMOTED TO ASSISTANT GENERAL MANAGER OF FASTENER DIVISION, UNITED SHOE MACHINERY CORPORATION

Jack H. Schofield, a member of the George Washington University class of 1951 and of Sigma Tau fraternity, has been promoted to the newly created position of assistant general manager of the Fastener Division of United Shoe Machinery Corporation, Shelton, Connecticut, according to a company announcement.

Schofield joined United's Fastener Division in 1957 as a "POP" rivet sales representative, later filling the positions of assistant sales manager, sales manager, and in 1960 was elevated to product manager. He will continue to serve in the latter capacity for the immediate future in addition to his new duties. Before joining United, he was employed by the York Corporation and the York Division of Borg-Warner Corporation as an industrial engineer. Prior to that, Schofield attended the U. S. Naval Academy and the U. S. Merchant Marine Academy.

PHOTOSENSITIVE GLASS FLUID AMPLIFIERS

BRADFORD, PA. -- Economical production of pure fluid systems for control and computation has been found to be feasible by using optical fabrication techniques with photosensitive glass.

Under contract with the Army's Harry Diamond Laboratories (formerly the Diamond Ordnance Fuze Laboratory) Corning Glass Works has developed techniques for making fluid amplifier sub-plates so that process variations have less of an effect on performance than assembly variations.

Total variation, Corning said, has been reduced to the point that economic production of complete systems will become a reality as soon as adequate functional designs become available.

Corning's optical fabrication techniques with photosensitive glass make possible the extremely complex patterns associated with miniaturized fluid systems. The company has been working in the fluid amplifier area more than a year, although its photosensitive glass technology is much older.

A fluid amplifier design is optically transferred to the glass, then the three-dimensional image is partially or completely etched through the glass to form channels, chambers, ports or holes. Layers of these chemically machined flat sub-plates can be thermally fused to form monolithic pure fluid systems. Being all glass, they are durable, stable, strong, temperature and radiation resistant, and impervious to most corrosive liquids and gases. Higher strength and temperature resistance can be obtained by converting the glass into a glass-ceramic.

Corning's work for Diamond Labs has consisted chiefly of determining dimensional tolerances for partially etched elements. The company reported that dimensions are generally being held as well as or better than in its standard process for making structural parts, screens and circuit boards for the electronics industry, usually requiring through-holes.

Corning has built proportional pressure and bi-stable amplifiers to Diamond Labs design. A random example cited dimensions for a power nozzle in a bi-stable device. It was intended to be .005-inch wide and .020-inch deep, with a nozzle area of .0001 square inch. It actually measured .0045-inch at the bottom, .0062 at the top, and .0193 in depth. Actual nozzle area was .000103 square inch, approximately three per cent more than the intended area. Measurements made on the other two nozzles on the device showed no variation in any dimension over .0002-inch -- ten times better than the target value.

One finding of the Corning-Diamond program is that all channels operating under a pressure differential should be separated by partitions no less than .020-inch wide. The same holds true of posts in open areas. Also, extremely narrow channels and small chambers present problems of keeping fresh acid at the interface during etching.

One of the most difficult problems lies in maintaining the shape of sharp wedges used as splitters. Corning said fluid amplifier designers should avoid sharp protruding angles when possible, since they will be attacked during etching from both sides as well as the leading edge. When essential, though, a radius on the tip can be calculated that will disappear at the desired point of time in etching.

Corning reported that no process limitations have been encountered to date that would require major design changes.

--Continued on Page 22

CIVIL ENGINEERS:

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SATELLITE IONIZATION—Continued from Page 11

Ninety minutes after launch, and for a considerable time thereafter, signal strengths were uniform and typical of normal radio propagation observed on the fifteen megacycle frequency over a period of years.

The sequence of events described above are so well timed with the flight path of ECHO I that coincidental ionization of the atmosphere by another source seems remote. The unexpectedly pronounced changes in propagation resulted from rapid decay of the satellite on the first orbit. As the balloon passed through the dense lower atmosphere, much more gas was ionized, therefore generating a much better conductive layer to reflect the waves more efficiently than would normally be expected.

The results of this experiment helped convince the author that further study of satellite ionization would be valuable.

CONCLUSIONS

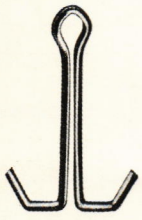
Much more will be learned about the mechanism of ionization, its use, and scientific implications. However, a complication has developed. Since there are several hundred pieces of satellites now in orbit, the effects of only one or two satellites can no longer be considered. Instead, the effects of each satellite must be considered. Because of the complexity of the problem, statistical methods of averaging large quantities of data will be required. Many organizations and individuals are now working on gathering such data. These studies promise to reveal much more about the behavior of our upper atmosphere. We may even discover that our satellites are raising the average amount of ionization, and consequently reducing the variation in radio propagation.

TECH NEWS—Continued from Page 20

NEWS IN SCREWS

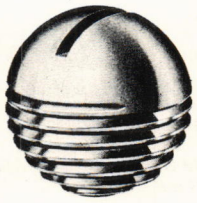
This information was obtained from Dumont Industrial Screw Corp., Los Angeles, California. All photographs are by Dumont Industrial Screw Corp.

Pre-Bent Cotter Pins



Bending cotter pins into the proper shape is a job which requires some dexterity and skill, and is time consuming. Installation of these new advanced Pre-Bent Cotter Pins can be done by any unskilled person in practically no time at all. This saves considerable time.

Screwballs



Every project or machine is not complete without at least one Screwball. Screwballs are available in assorted sizes and with different surface finishes. Some are coated with chrome and/or zinc and some are just plain screwballs.

Square Deal Screws

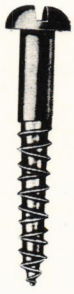
These new screws are designed especially for use with square holes. The wisdom of using round pegs for round holes is apparent. However, up to this point there has been no solution to the problem of square holes.

High Speed Bolts

This new line of High Speed Bolts requires only half the time to fasten because there are only half the usual number of threads. This means that you can use twice as many bolts per unit area with no increase in labor costs.

Cork Screws

The public has for a long time demanded large quantities of Cork Screws. For years the fastener industry has had to supply Cork Screws made of steel. Now Cork Screws are available which are made of genuine cork.

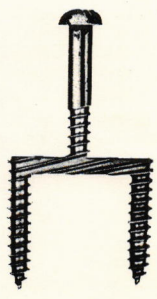


Combination Thread (Right and Left Hand)

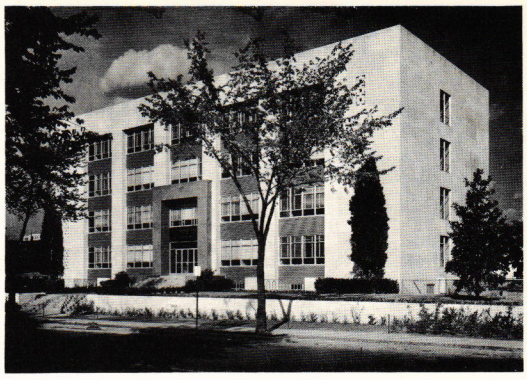
This new development is a boon to production. Now with this New Combination Thread, one can insert or remove the screw by turning the screw either right or left. No time is lost in stopping to think.

New Joining Screw

This New Joining Screw takes the place of two ordinary screws. This screw is particularly useful on butt joints and miter joints. When this screw is used 50% of time and labor will be saved.



CAMPUS NEWS



ASME-ASCE-AIEE-IRE

On February 6, 1963, each professional society held its regular business meeting. All societies were asked by the Engineers' Council to review the proposed new Constitution of the Engineers' Council, and approve or disapprove of all or part of it. Other business was discussed by each society, including general elections for the ASCE's. The new officers for this society are:

President	— Frank Leone
Vice-President	— Stanwood Armington
Recording Secretary	— Bill Rohde
Corresponding Secretary	— Bill Pryor
Treasurer	— Charles Herbert
Program Chairman	— Jack Taylor

After the business meetings, the three societies adjourned to the Engineers' Mixer, where Mr. Robert Baumann, NASA's project manager of the Ariel I satellite, and a graduate of The George Washington University, gave a complete summary of the work and progress of the satellite from the time it was first suggested to the time it was put into orbit. Included in the talk was an analysis of the final product in the areas of accuracy, usability, and stability. To implement his speech, Mr. Baumann had a 20 minute movie and numerous illustrative slides. At the conclusion of his speech, Mr. Baumann joined the guests at the meeting for refreshments.

THETA TAU

Theta Tau, national professional engineering fraternity, held its Twenty-Fourth Biennial Convention at the Brown Hotel in Louisville, Kentucky, December 27-30, 1962. Representing the Theta Tau Chapter at The George Washington University School of Engineering and Applied Science were Richard H. Singer, delegate, and Harvey J. Flatt and Tom McIntosh, guests.

At their February meeting, the Theta Tau Chapter heard a full report of the happenings at this convention. Plans are also being made for the Theta Tau Banquet and Ball to be held in the near future.

SIGMA EPSILON

The Sigma Epsilon Engineering Honorary will henceforth be known as the D. C. Gamma Chapter of Tau Beta Pi National Engineering Honorary Fraternity. The formal initiation was held on February 16, 1963. (See Tau Beta Pi article, this issue.)

Fellow Students,

At its last regular meeting, the Engineers' Council adopted a new Constitution. I would like to explain briefly some of the changes, and what we hope to accomplish by making these changes.

Under the new system, an incoming Council will take office in April instead of in June. It is hoped that the "extra" time will allow the new Council to become organized and to start making plans for the coming school year before the usually unproductive summer months. It is no longer sufficient for a new Council to wait until the fall to begin operating. The deadline for the University calendar has been moved up to August 1, the University fiscal year begins on September 1 and budgets should be submitted well in advance of that date, and the Mechelecivedit editor, who is chosen by the Council, needs more than one month to pick a staff and publish the October issue.

The member organizations of the Council now include the Institute of Electrical and Electronic Engineers, instead of the AIEE-IRE, and the D. C. Gamma chapter of Tau Beta Pi.

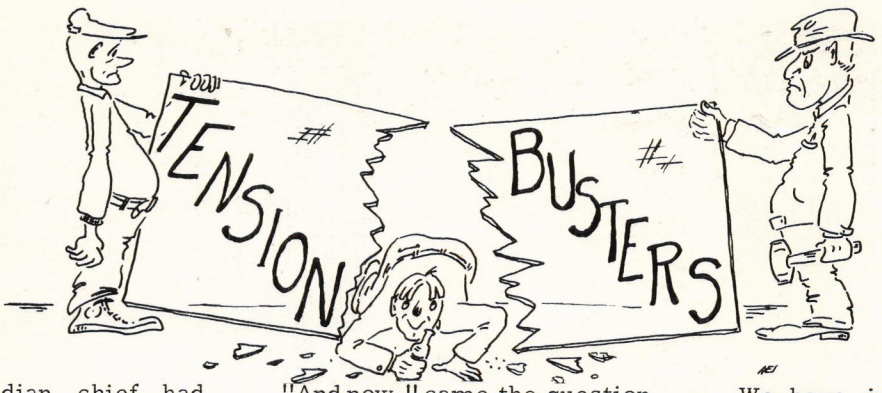
There will no longer be Freshman, Sophomore, Junior and Senior representatives. Instead there will be representatives from the Introductory, Intermediate, and Advanced levels. There will still be an election in the fall so that the incoming "freshmen" class will have representation on the Council. The two graduate representatives will now be appointed, instead of elected.

An Advisory Committee has been established. It will consist of the Presidents of all member organizations and will serve as a cabinet to the President of the Council.

The new Constitution more clearly defines the responsibilities of the Council members and officers. Written reports will now be required upon the completion of any committee assignments or upon retirement from office. It is hoped that these reports will be of benefit to future Council members. Also a set of by-laws will now be kept, again for the purpose of aiding new members of the Council. In the past, too many man-hours of experience have been lost when a Council went out of office. Many of the new provisions provide for and encourage a greater cooperation between an incoming and a retiring Council.

As you can see, most of the changes affect only the operating procedure of the Council. The purpose of your Engineers' Council will continue to be "to provide liaison between the student body of the School of Engineering and Applied Science of The George Washington University, and the faculty, administration, and the student government of the University, in all matters affecting the general interest and welfare of the student body, the School of Engineering and Applied Science, or the University."

Harvey J. Flatt, President
Engineers' Council



A certain Indian chief had three squaws. He kept one in a tepee covered with deer hide, one in a tepee covered with buffalo hide, and one in a tepee covered with hippopotamus hide. In due time, the squaw in the deer hide tepee presented him with a son, as did the squaw in the buffalo hide tepee. However, the squaw in the hippopotamus hide presented the chief with twin sons.

Moral: The squaw in the hippopotamus is equal to the sum of the squaws in the other two hides.

* * *

The latest in drinks: Vodka and milk of magnesia. It's called a Phillips Screwdriver.

* * *

In 1905 when girls did swim
They dressed like Mother Hubbard
But now they have a different whim —
They dress more like her cupboard.

* * *

Overheard in Monroe Hall: "If I told you that you had a good figure, would you hold it against me?"

* * *

Question on a job application: "Are you a natural born citizen?" Answer: "No, Caesarean."

* * *

A little boy talking to his mother of his recent trip to the circus: "There were tigers and tigresses, monkeys and monkeyesses, elephants and elephantesses, and bears."

* * *

A C.E. had prepared for an oral exam in history by writing answers on the inside of the waistband of his trousers. Casually hooking his thumbs into his belt and turning down the top of his pants, he lowered his head and read off the inscribed notations of names and dates as the prof. questioned him.

"And now," came the question, "tell me the name of the Rough Rider's colonel in the Spanish-American War who later became President of the United States."

The student took a quick glance at the lining of his trousers. "Robert Hall," he said.

* * *

Nowadays when they speak of a girl reaching the 'awkward age', it means that she's too old for teddy bears and too young for wolves.

* * *

Mother: What makes you think that one day Junior will be President?

Father: He says more things that sound well and mean nothing than any other boy I know.

* * *

C.E.: What do you call a man who's been lucky in love?

M.E.: A bachelor.

* * *

We've often heard it said that gasoline and alcohol don't mix. Actually, they do, but they just don't taste good.

* * *

Overheard in the testing lab: "Did you say your girl's legs are without equal?"

"No, I said they knew no parallel."

* * *

You haven't had a real hangover until you can't stand the noise made by Bromo-Seltzer.

* * *

One of the most disconcerting fluffs ever delivered by a radio announcer occurred during a visit made by the Governor of the Virgin Islands to Washington, D. C.

Describing the event, the beaming newscaster, who shall never again be the same, said, "Today the White House received a special guest in the person of the Virgin of Governor's Island."

* * *

Thought-Of-The-Month: A pinch of salt is greatly improved by dropping it into a can of beer.

We have just received word from Prof. Kolodney that things are so dry in New Mexico that the trees are going to the dogs.

* * *

What makes people walk in their sleep?

Twin beds.

* * *

Two cannibals were in an asylum. One was tearing pictures of men, women and children out of a magazine and eating them.

"Tell me," said the other, "is that dehydrated stuff any good?"

* * *

Policeman (producing notebook) "What's your name?"

Motorist: "Aloysius Alastair Syprian."

Policeman (putting notebook away): "Well, don't let me catch you again."

* * *

Social Worker: "Sir, would you be interested in contributing something to the old ladies' home?"

Spendthrift: "Sure, I'll send my mother-in-law over tomorrow."

* * *

For years the bum slept under bridges and in ditches. Then one day he switched to culverts and became a man of distinction.

* * *

She had been dancing with a stranger, then left the floor with him. Her fiance finally found her and pulled her away. As they returned to the dance, he said, "I saw that stranger kissing you. Who is that guy? I'll teach him a thing or two."

"Ah, darling," she sighed, "I don't think you could."

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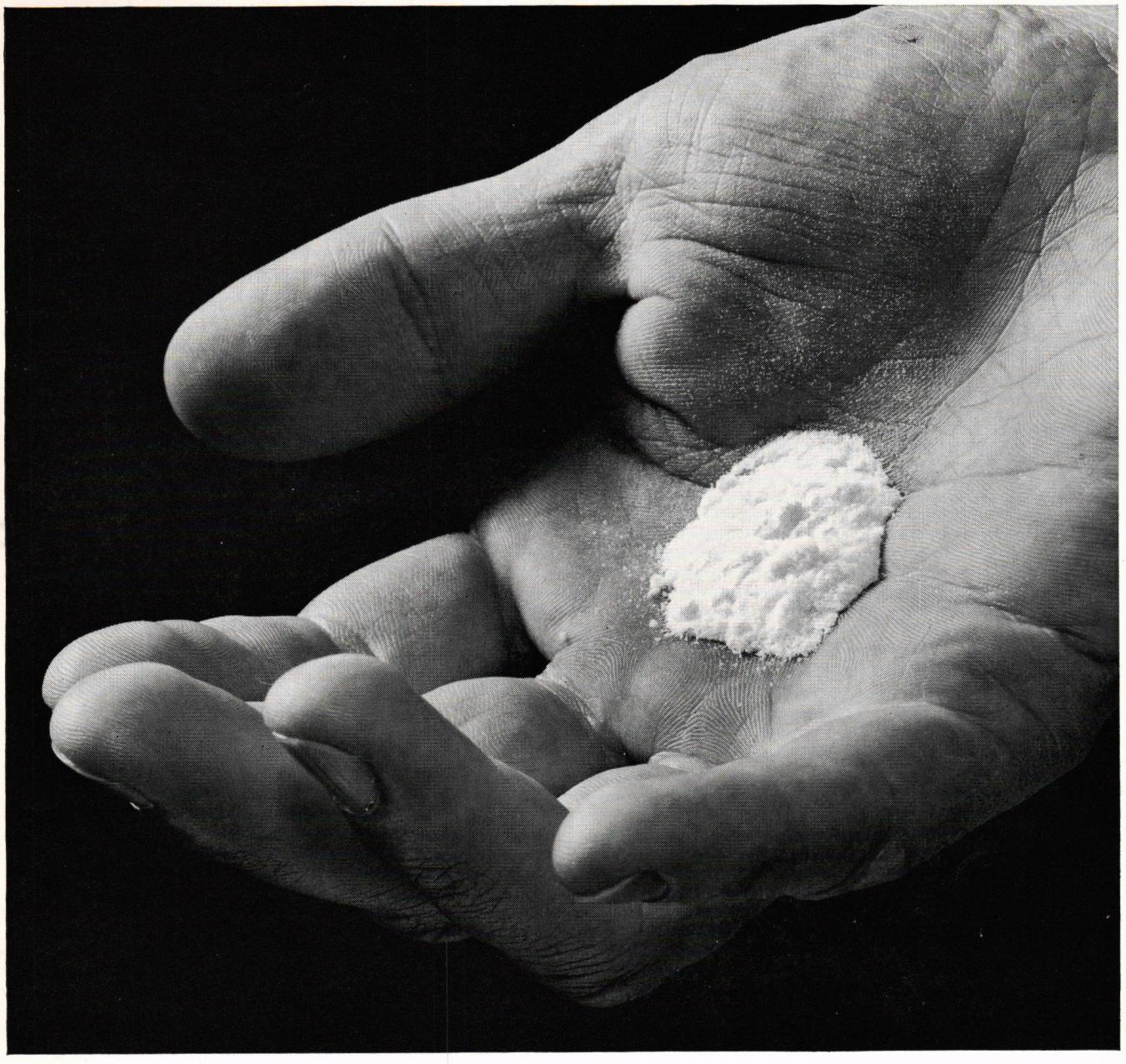
Kodak beyond the snapshot...



The powder is vitamin E. Vitamin E is essential to human life. Also to poultry and livestock. This much is enough for about 200 multivitamin tablets. We make so much of it for the pharmaceutical manufacturers that the operation long ago entered the domain of chemical engineering.

It's an especially interesting kind of chemical engineering, related to the kind we have been developing over the years in our basic business of manufacturing photographic materials.

Vitamin E is in no way a by-product of photographic manufacturing. Only the engineering skills behind it are a by-product. They come out of the maddeningly sensitive nature of sensitized film and paper. Now they are available for the thousands of other fascinating things we make besides vitamin E.

We need more chemical engineers to indoctrinate in our ways. The snapshot business is excellent, but photography has gone far beyond the snapshot and we have gone far beyond photography. *Please drop us a note asking for an explanation of what all this has to do with you.*

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Manufacturing Careers Offer Diversity, Challenge and Opportunity

An Interview with G.E.'s H. B. Miller, Vice President, Manufacturing Services

Halbert B. Miller has managerial responsibility for General Electric's Manufacturing Services. This responsibility includes performing services work for the Company in the areas of manufacturing engineering; manufacturing operations and organization; quality control; personnel development; education, training and communications; materials management; purchasing and systems as well as the Real Estate and Construction Operation. Mr. Miller holds a degree in mechanical engineering and began his General Electric career as a student engineer on the Company's Test Course

For complete information about General Electric's Manufacturing Training Program and for a copy of G.E.'s Annual Report, write to: Personalized Career Planning, General Electric Company, Section 699-06, Schenectady 5, New York.

Q. Mr. Miller, what do engineers do in manufacturing?

A. Engineers design, build, equip, and operate our General Electric plants throughout the world. In General Electric, this is manufacturing work, and it sub-divides into categories, such as quality control engineering, materials management, shop management, manufacturing engineering, and plant engineering. All of these jobs require technical men for many reasons. First, the complexity of our products is on the increase. Today's devices—involving mechanical, electrical, hydraulic, electronic, chemical, and even atomic components—call for a high degree of technical knowhow. Then there's the progressive trend toward mechanization and automation that demands engineering skills. And finally, the rapid development of new tools and techniques has opened new doors of technical opportunity—electronic data processing, computers, numerically programmed machine tools, automatic processing, feedback control, and a host of others. In short, the requirements of complex products of more exacting quality, of advanced processes and techniques of manufacture, and of industry's need for higher productivity add up to an opportunity and a challenge in which the role of engineers is vital.

Q. How do opportunities for technical graduates in manufacturing stack up with other areas?

A. Manufacturing holds great promise for the creative technical man with leadership ability. Over 60 percent of the 250,000 men and women in General Electric are in manufacturing. You, as an engineer, will become part of the small technical core that leads this large force, and your opportunity for growth, therefore, is unexcelled. Technical graduates in manufacturing are teamed with those in marketing who assess customer needs; those in research and development who conceive new products; and those in engineering who create new product designs. I sincerely believe that the role of technical graduates of high competence in the manufacturing function is one of the major opportunities for progress in industry.

Q. What technical disciplines are best suited to a career in manufacturing?

A. We need men with Doctor's, Master's, and Bachelor's degrees in *all* the technical disciplines, including engineering, mathematics, chemistry and physics. We need M.B.A.'s also. General Electric's broad diversification plus the demands of modern manufacturing call for a wide range of first-class technical talent. For one example: outside of the Federal Government, we're the largest user of computers in the United States. Just think of the challenge to mathematicians and business-systems men.

Q. My school work has emphasized fundamentals. Will General Electric train me in the specifics I need to be effective?

A. Yes, the Manufacturing Training Program is designed to do just that. Seminars which cover the sub-functions of manufacturing will expose you to both the theoretical and practical approaches to operating problems. Each of the succeeding jobs you have will train you further in the important work areas of manufacturing.

Q. After the Program—what?

A. From that point, your ability and initiative will determine your direction. Graduates of the Manufacturing Training Program have Company-wide opportunities and they continue to advance to positions of greater responsibility.

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